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Computational assessment of a finite element method for axisymmetric eddy current problems with hysteresis. *

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Abstract

This work deals with the mathematical analysis and the computation of transient electromagnetic fields in nonlinear magnetic media with hysteresis. The results obtained complement those in [1, 2], where the mathematical and numerical analysis of a 2D nonlinear axisymmetric eddy current model was performed under fairly general assumptions on the **H**–**B** curve but without considering hysteresis effects. In our case, the constitutive relation between **H** and **B** is given by a hysteresis operator, i.e., the values of the magnetic induction depend not only on the present values of the magnetic field but also on its past history. Like in [1], we assume axisymmetry of the fields and then we consider two kinds of boundary conditions. Firstly the magnetic field is given on the boundary (Dirichlet boundary condition). Secondly, the magnetic flux through a meridional plane is given, leading to a non-standard boundary-value problem. For both problems, an existence result is achieved under suitable assumptions. For the numerical solution, we consider the Preisach model as hysteresis operator, a finite element discretization by piecewise linear functions, and the backward Euler time-discretization. We report a numerical test in order to assess the order of convergence of the proposed numerical method. Finally, we validate the numerical scheme with experimental results. With this aim, we consider a physical application: the numerical computation of eddy current losses in laminated media as those used in transformers or electric machines.

Key words: transient eddy current, axisymmetric problem, hysteresis, finite elements

Mathematics subject classifications (1991): 65M60, 78A55, 78M10

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